Position paper for Context-aware workshop

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My position as a program manager at DARPA (Defense Advanced Research Projects Agency) provides me with the opportunity to direct funding and hence, focus research efforts in context-aware computing.

In trying to define a large scale research program in this area I have addressed some of the 6 questions posed by the workshop organizers. My usage scenario has focused on mobile workers carrying out physical tasks in an outdoor setting. In this scenario I view contextual information as being used to reduce the overhead on the user wishing to access information. Thus context is used both in filtering information and in effectively delivering information to the user. While I think that the use of context will be advantageous in desktop use as well as for mobile workers, I believe that the advantages in mobile computing will be the most advantageous.

Context then consists of information about the user's task, information about the user's environment, information about the user's physical and mental state, and information about the presence and condition of the user's computing equipment. Context information can be obtained from existing information (calendars, to-do lists), from user models and task models, and from sensor information. Sensor information would include such input as image processing (what the user is seeing and doing, where the user is), GPS for location, body sensors that indicate the health and physical activities of the user (under stress, running, walking) and the ambient conditions (noise level, number of people in the area, identification of people in the area). Novel sensors such as RF tags and buttons, pressure pads in floors to detect people, retina scans, etc. could be employed in obtaining information about the user's context.

I envision the user as having a number of computing devices, including multiple input and output devices. All devices would be networked using wireless technology such as Bluetooth. Context would then also include the number and capabilities of such devices, including power requirements and the current battery levels.

Three grand challenges exist for HCI research.
1. Representation of and reasoning about contextual information
2. Specification of user interactions independent of device/ modality.
3. Exploration of advantages/ applications/ methods of adding contextual information to input and adaptation of output based on contextual information.

Clearly the number of heterogeneous sources of data need to be combined to represent context. Assembling the proper granularity of sensor data and normalizing the data so that we can utilize the various sources (as well as yet undeveloped sources) will be a research effort. A type of probabilistic reasoning needs to be implemented to determine characteristics of the user's current context that would require special adaptation. One might image a fuzzy pattern matching or a Bayesian net used for this purpose. Other issues that will have to be addressed include how contextual information flows into the representation - push versus pull; distribution of contextual information to user interface generators and applications - push versus pull; and level of confidence in recognition of the context.

Secondly, if we are to successfully use contextual information to filter information retrieved and to adapt information delivery, the user interface must adapt correctly to the context. We will need a device independent, context-independent representation of user interactions and heuristics of the most effective adaptation in various contextual situations. For this to be successful for users, there must be an element of
machine learning to ensure that adaptation takes place at an individual basis. In order for learning to occur, individuals must be able to easily access the contextual information that the computer has recognized and adjust either the recognition or the adaptation that has occurred in the interface. This means that learning needs to occur in both contextual recognition and in the interaction adaptation heuristics.

The third challenge is to develop the heuristics for interface adaptation. This would involve a significant experimental component as well as developing a representation for the heuristics.

My objective in attending the workshop is to determine whether the challenges I have outlined are in line with the challenges that researchers in this area currently view as the major focus for research. In addition, I would like to outline feasible approaches that researchers are pursuing in the major research areas. While I am encouraged by the number of researchers who are now investigating issues associated with context-aware computing, I think that significant progress could be made if an interdisciplinary research focus were initiated. It seems likely that experimental work combined with artificial intelligence research could contribute much to the HCI efforts in this area. In addition, close ties to wireless networking, sensor processing development and research and new input/output modality work would be beneficial.

**Brief Bio:**

I am currently a program manager at the Defense Advanced Research Projects Agency (DARPA), USA where I fund and manage research programs in the Information Technology Office (ITO). Our current funding efforts in the area of human-centered systems have been mainly collaborative systems, information management, and speech recognition systems. I am interested in starting a funding initiative in the area of context-aware computing. My assignment at DARPA is temporary and I will return to my position at the National Institute of Standards and Technology (NIST). In this position, I am developing evaluation methodologies for interactive systems. This includes a focus on pervasive computing.

My background prior to working at NIST includes a position on the computer science faculty at Portland State University, usability lab and group manager in industry (Intel), and usability consultant (UserWorks).